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CRUISE RESULTS

NOAA SHIP MILLER FREEMAN, CRUISE 94-09
WEST COAST UPPER CONTINENTAL SLOPE GROUNDFISH GEAR RESEARCH CRUISE

The Resource Assessment and Conservation Engineering (RACE) Division of the Alaska Fisheries Science Center (AFSC) recently completed a gear research cruise on the west coast upper continental slope. This report summarizes the preliminary results of the cruise.

ITINERARY

A gear research cruise was conducted aboard the NOAA ship Miller Freeman between October 16, 1994, and November 13, 1994, off the coast of Oregon (lat. 44?40' N to lat. 45?35' N) in waters 183 m-1,280 m deep. Exchange of scientific personnel occurred in Astoria, Oregon, during a mid-cruise break lasting from October 29-30. The cruise period was divided equally between two studies, each providing a distinct and independent approach to addressing concerns about the performance of trawl gear used in National Marine Fisheries Service (NMFS) surveys of the upper continental slope fish resources off Oregon, Washington, and California. The first half of the cruise compared our standard area-swept bottom trawl survey and a line transect survey using a video sled. The second leg of the cruise investigated bottom trawl gear performance using different net configurations and towing protocols.

OBJECTIVES

The impetus for conducting this research in lieu of the standard survey was the concern voiced by the fishing industry that the slope survey fishing operations are faulty which have led to the restrictive commercial catch quotas on Dover sole (*Microstomus* *pacificus*), thornyheads (*Sebastolobus* spp.) and sablefish (*Anoplopoma fimbria)* recently imposed by the Pacific Fishery Management Council in response to 1994 stock assessments. Some fishermen contend that our trawl survey data are not accurate because there are indications, such as excessive mud in trawl catches and inconsistent gear performance, that the trawl is not fishing properly. In response to their concern, we conducted this experimental cruise to research performance of the survey trawl. Ultimately, we want to insure (or determine) that the poly Nor'eastern bottom trawl performs consistently as a standardized sampling tool and that it provides a reasonably accurate estimate of fish density.

To assess how well the slope trawl survey estimates fish density a comparative survey was designed using a video bottom sled. A video sled offers an independent estimate of fish density. Video images will also aid in understanding trawl performance on the upper continental slope by providing details of the habitat's physical and biological characteristics. The primary objectives of the video/trawl comparison experiment were to:

1. collect data on fish density from a towed video sled survey to compare with catch rates from an area-swept trawl survey, and

2. characterize the physical and biological environment of the upper continental slope to provide information on trawl performance in relation to the bottom conditions.

During the second leg of the cruise, a gear performance experiment was conducted to test the impact of modifications to the gear or towing protocol on net performance and trawl catch rates. The goals of this experiment were to identify changes to the trawl system that would: improve gear performance, have minimal affect on net selectivity to maintain continuity with the slope survey data time series, and avoid reducing the maximum depth limit (1,300 m) of the past slope surveys. Improved gear performance in this case means minimal fluctuations in the net's fishing dimensions within and between tows, and consistent net performance under a variety of conditions (e.g., wind, current, bottom type, trawl operator, etc.). Better gear performance, although, does not necessarily mean that the net opens wider or that fish catch rates increase. The primary objectives of the trawl modification experiment were to:

1. measure a number of variables of trawl performance to test the null hypothesis that gear performance is the same on soft bottom for modifications to the survey trawl configuration

and towing protocol;

2. collect data on species composition and size composition of the catch to investigate how the selectivity for different fish species varies with each trawling modification; and

3. collect data to derive a new scope table for a 2.0 knot towing speed using newly marked trawl warps.

VESSEL AND GEAR

The NOAA ship Miller Freeman is a 65.5-m (215-ft) stern trawler equipped with modern trawling, oceanographic and hydrographic sampling systems and navigation and fishing electronics. The standard survey trawl used was the polyethylene high-opening Nor'eastern bottom trawl equipped with mud-sweep roller gear constructed of 203-mm (8-in) solid rubber disks strung on 16-mm high tensile chain. Dimensions of this net are: 27.2-m (89-ft) headrope, 37.4-m (123-ft) footrope including the "flying wings", body constructed of 127-mm stretched mesh polyethylene netting, 89-mm stretched mesh codend, and a 32-mm stretched mesh codend liner. Each wing was attached to a 1000-kg (2,200-lb), 1.8-m x 2.7-m (6-ft x 9-ft) steel V-door using three 55-m (180-ft) dandylines made of 16-mm galvanized steel cable. A SCANMAR[1] acoustic trawl mensuration system was used to measure spread of trawl doors and fishing dimensions of the Nor'eastern trawl. A Furuno wireless netsonde system was used to monitor bottom contact and net height throughout each trawl haul. A Richard Brancker XL-200 submersible data logger was attached to the trawl and used in conjunction with a Trimble Global Positioning System (GPS) unit to record data on the time, depth, water temperature, and geodetic position during each trawl. Newly developed tilt sensors were used to measure the bottom contact of the footrope and the pitch and roll angles of the V-doors. The V-door pitch and roll sensors were attached on the back and middle side of both port and starboard doors and the bottom contact sensor was attached to the footrope where it connects to the breast line of the flying wing.

Dr. Waldo Wakefield, the Science Director at the National Undersea Research Center (NURC) and a Research Professor at the Institute of Marine and Coastal Science at Rutgers University, built the video sled camera system for the video sled/trawl comparison experiment. The video camera system was carried on

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[1]Reference to trade names and/or commercial firms does not constitute U.S. Government endorsement.

a sled constructed of hot-dipped galvanized schedule 40 two-inch steel pipe measuring 366 cm long by 213 cm wide by 152 cm high, weighing about 500 kg. The camera was a Deepsea Power and Light Autonomous Video Camcorder System (AVCS) powered by two sets of 24 volt/38 amp hour batteries and lighted with two 150-watt SeaLites.

EXPERIMENTAL DESIGN AND METHODS

Video Camera Sled/Trawl Comparison Experiment

Sampling stations for the first half of the cruise were located off the Oregon coast between lat. 44?40'N and lat. 45?30'N at depths of 450 m, 750 m, and 1,150 m. Sampling sites were flat or gently sloping, free from obstructions, and composed of a soft mud bottom. Sampling was conducted on a 24-hour basis. Replicate samples were made at each depth for each gear type. Sampling at each station alternated between the video camera sled and trawl net. The number of replicates of each gear type and depth was constrained by time. While towing an effort was made to avoid crossing over the path of any previous tows. Both net and sled hauls were towed along isobaths as closely as was practical throughout each tow. The video camera sled was towed on the sea floor using the main starboard trawl wire at speeds between 0.75 m/s and 1.0 m/s (1.5 kts and 2.0 kts) for two to three hours. During each tow, the trawl wire in front of the camera was maintained 25 m to 35 m above the sea floor by adjusting the ship's speed or the amount of trawl wire out. This altitude was monitored with a 12 kHz pinger attached at the connection between the trawl wire and the camera sled rigging. The Rapp Hydema hydraulics were modified for camera tows to allow the starboard trawl winch to freewheel in the event of a hang-up.

Trawl Modification Experiment

Prior to the cruise, new trawl warps were marked every 50 m to keep an accurate account of how much wire was paid out during trawling operations. During the first two days of the first leg of the cruise a new scope table for 2.0 kts towing speed was developed to utilize the marked warps. This was accomplished by "flying" the trawl over deep water using warp lengths of 200 m, 600 m, 1,000 m, 1,400 m, and 1,800 m, and measuring the depth at which the trawl settled using the Furuno netsonde and a Seabird Seacat Profiler. Towing speed was held constant for at least 15 minutes at each warp length. Similar tests were done at 2.5 kts and 3.0 kts towing speeds using warp lengths of 200 m, 1,000 m, and 1,800 m. Trials were conducted while towing with and against the current and while the trawl wire was paying out and coming in.

Trawl stations were occupied off the Oregon coast between lat. 45?05'N and lat. 45?35'N at depths ranging from 460 m to 480 m. Differences between trawl configurations were tested using a randomized block design. Within each block, various trawl configurations or treatments were done in random order. Tows were conducted without crossing over the previous tow paths. Depths ranged from 460 m to 480 m and the bottom was flat or gently sloping, free from obstructions, and composed of soft mud. The net was towed at an average towing speed of 1.0 m/s (2.0 kts) for 30 minutes. The autotrawling mechanism on the Rapp Hydema system was not used and marks on the trawl warps were used to determine wire out.

Suggestions for modifying the trawl net or towing protocol were solicited and received from a variety of individuals within the fishing industry (harvesters as well as trawl manufacturers) and the scientific community. After careful consideration, three modifications were chosen: 1) shorter scope (Table 1), 2) a four-point bridle attachment to the V-door, and 3) lighter ground gear. These three modifications resulted in eight possible trawl configurations or treatments (Table 2).

Shorter scope was chosen as a treatment because results from the earlier scope experiment indicated that more scope was being used in previous surveys than was necessary. Additional weight from extra wire may cause doors to fall over resulting in poor trawl performance. The four-point bridle on the V-doors may also prevent the doors from falling over by forcing the doors to maintain a certain angle of attack (ideally 35?-40?). Maintaining the door's angle of attack may reduce the variability in door and net spread, thereby stabilizing the net's fishing dimensions. Virtually all deep-water commercial fishermen in Eureka use some version of a four-point bridle attachment and are able to effectively tow their nets at speeds ranging from 1.5 kts to 2.0 kts (Liem Massey--Pacific Trawl Nets, and Gary Loverich--Research Nets, personal communications). Another possible explanation for the large mud tows that leads to questionable gear performance during past surveys was the heaviness of the standard mudsweep ground gear. Excessive weight in the ground gear would tend to make it dig into the soft mud bottom causing erratic net behavior and large catches of mud and benthic invertebrates. About 700 lbs. were eliminated from our standard mudsweep ground gear by removing a 1/2-inch long link chain attached to the footrope, replacing a 1/2-inch long link chain that strings the cookies with a 3/4-inch cable, and substituting cable clamps for 3.2 kg toggles. Increased towing speed was considered as a potential experimental factor but was not selected because higher towing speed would change the net's selectivity relative to past surveys and would also reduce the maximum depth limit of our survey. The decision was made even though increased tow speed would tend to stabilize net performance.

All catches were sorted to the lowest possible taxon, weighed, counted, and processed according to standard AFSC protocols, and selected species were measured. Biological data from individual specimens, such as length, sex, otoliths, maturity, and weight, were obtained for sablefish and giant grenadier (*Albatrossia pectoralis*) during the first leg only. Table 3 summarizes the biological data collected during the entire cruise.

RESULTS

Video Sled/Trawl Comparison Experiment

Several days were required to perfect techniques for rigging, deploying, and retrieving the camera sled. Seventeen camera sled tows and 22 trawl net tows were completed during the video/trawl comparison experiment (Figure 1). Of these, 12 were paired camera sled/trawl net tows done at depths of 450 m, 750 m, and 1,150 m (four pairs at each depth). Four of the 17 camera sled tows were unsuccessful because of video camera or 12 kHz pinger malfunctions. Three of the 22 trawl net tows were unsuccessful due to winch failure, improper scope, or problems with gear mensuration equipment.

Procedures for retrieving and analyzing the video data are being developed. Fish abundance and spatial distribution data will be extracted from video images by using a program that controls a Hi-8 computer video deck and records events entered by an observer's keystrokes. Fish lengths for selected species will be estimated using OPTIMAS video imaging software. Fish density for different fish species will be estimated using line transect sampling theory using the DISTANCE program (Laake et al. 1993)[2].

Gear Performance Experiment

Results from the scope trials indicated that less wire or shorter scope could be used at 2.0 kts than has been used during prior surveys (Table 1). For this cruise, the new and shorter scope table along with standard heavy footrope and two-point door was used for all trawls during the video sled/trawl comparison experiment and as one of three treatments during the gear performance experiment.

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[2]Laake, J.L., S.T. Buckland, D.R. Anderson, and K.P. Burnham. 1993. DISTANCE user's guide, v2.0. Colorado Cooperative Fish and Wildlife Research Unit, Colorado State University, Fort Collins, Colorado. 72 pp.

A total of 96 tows was successfully completed during the trawl modification experiment providing 12 replicates for each block of 8 treatments. Eight additional tows that were unsuccessful. A full set of SCANMAR data on door width, net width, and net height were obtained for all but a few tows. Roll tilt sensor data was collected from 98 tows from both doors. Pitch sensor data was collected for all 98 tows from the starboard door but the pitch sensor on the port door functioned properly on only 73 tows. Bottom contact sensor data was collected for 76 trawl net tows.

Analyses will be conducted on the gear mensuration and tilt sensor data to determine which trawl configuration or treatment was the most stable and the least variable. Results from this study will help determine the preferred trawl configuration for future slope surveys. Preliminary analysis of the gear mensuration data (Table 4) indicate that gear width and height were less variable for the four-point door bridle regardless of ground gear weight or scope length. Net heights and net and door widths were much more variable with the combination of the two-point door bridle and the heavy ground gear, independent of scope length. Average net height and door and net widths for the two-point bridle doors generally had higher variances. The two-point bridle had the least variability when fished with the light ground gear and longer scope. Tilt sensor data are still being summarized.

Preliminary analysis of the average catch rates (Table 5) shows less than twofold differences among the different trawl configurations for all the primary target species. This preliminary summary indicates that higher catch rates occurred for the treatments that showed more erratic net performance. A detailed statistical comparison to test significant differences in catch rates among treatment groups is in progress for primary species.

Additional activities accomplished during the gear research cruise included:

1. the camera sled was towed over the "footprint" of three trawl net tows using different scopes and trawling techniques. Unfortunately, water turbidity from the trawling obscured video images of the bottom;

2. one trawl station was completed in 60 m to collect small English sole (*Pleuronectes vetulus*) for a graduate student at Oregon State University to collect maturity data; and

3. tissue samples for mitochondrial DNA analysis were obtained

from 15 aurora rockfish (*Sebastes aurora*) for the Southwest Fisheries Science Center to study the taxonomic relationships of rockfishes.

Gerald Gunnari, a commercial fisherman and member of the Fishermen's Marketing Association from Charleston, Oregon, participated in the second leg of the gear research cruise. Mr. Gunnari's concern over performance of the survey trawl net during last year's West Coast Slope Survey was the impetus for doing this year's gear research cruise. Observations and suggestions from Mr. Gunnari continue to be helpful in resolving a number of issues concerning our slope survey operations and methods.

SCIENTIFIC PERSONNEL

Leg I (October 15-29)

Robert Lauth	Chief Scientist, AFSC
Peter Adams	SWFSC
Bill Flerx	AFSC
Dave King	AFSC
Craig Rose	AFSC
Jim Smart	AFSC
Steve Syrjala	AFSC
Waldo Wakefield	NURC

Leg II (October 30-November 15)

Robert Lauth	Chief Scientist, AFSC
Scott McEntire	AFSC
Bill Flerx	AFSC
Robin Harrison	AFSC
Dave King	AFSC
Jim Smart	AFSC
Michael Martin	AFSC
Allen Harvison	AFSC
Mike Mac Ewan	AFSC
Ken Weinberg	AFSC
Gerald Gunnari	FMA

AFSC = Alaska Fisheries Science Center, Seattle, Washington
NURC = National Underwater Research Center, New Brunswick, New Jersey
SWFC = Southwest Fisheries Science Center, Tiburon Laboratory, Tiburon, California
FMA = Fisherman's Marketing Association, Coos Bay, Oregon

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